

## CHILD COVERAGE WITH MOSQUITO NETS AND MALARIA TREATMENT FROM POPULATION-BASED SURVEYS IN AFRICAN COUNTRIES: A BASELINE FOR MONITORING PROGRESS IN ROLL BACK MALARIA

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**Abstract.** We assessed the proportion of febrile children less than five years old with prompt effective antimalarial treatment and the proportion of those less than five years old sleeping under insecticide-treated nets (ITNs) or any mosquito net the preceding night in African malarious countries. Data were reviewed from 23 Multiple Indicator Cluster Surveys and 13 Demographic and Health Surveys conducted between 1998 and 2002. A median of 53% of febrile children received antimalarial treatment. A median of 84% of these treatments, however, involved chloroquine, and the proportion of treatments given within two days of onset of symptoms was unknown in most surveys. Median coverages of those less than five years old with any net and ITNs were 15% and 2%, respectively. Use of nets, and especially ITNs, was consistently lower in rural than in urban areas. At the outset of intensified malaria control under Roll Back Malaria, coverage with principal interventions was far below the target of 60% set for Africa in 2005.

### INTRODUCTION

The Roll Back Malaria (RBM) partnership, established in November 1998 by the World Health Organization, the United Nations Children's Fund, and the World Bank, is a multiyear global effort to reduce malaria mortality, morbidity, and economic consequences.<sup>1</sup> Initial RBM efforts focused on consensus building for strategy development and for advocacy within and outside of the partnership. More recently, RBM through its many partners provides regional, sub-regional, and country support in Africa, where most malaria cases and deaths occur.<sup>2</sup> It has focused on high coverage for three evidence-based strategies: prompt effective treatment of acute cases, use of insecticide-treated mosquito nets (ITNs), and intermittent preventive treatment (IPT) in pregnancy (<http://www.rbm.who.int/partnership/>).

Controlled trials of ITNs show that mortality in children less than five years old can be reduced by 17% with high coverage of this intervention.<sup>3,4</sup> Effective and prompt antimalarial treatment reduces mortality, and possibly morbidity by preventing neurologic complications and severe anemia, as shown in trials that promoted improved home management of child fevers by educating care takers.<sup>5–7</sup> Intermittent preventive treatment reduces maternal fever episodes and anemia, and results in reduced infant parasitemia, anemia, and sometimes higher average birth weight in infants. Although this has not been demonstrated, this is likely to reduce infant and child mortality.<sup>8</sup>

In April 2000, African heads of state participated in the Abuja Summit on RBM and agreed to targets for coverage with these strategies in sub-Saharan Africa whereby 60% of children less than five years of age with fever should receive prompt and effective antimalarial treatment, 60% of households members, especially children less than five years of age, should sleep under ITNs, and 60% of pregnant women should receive IPT.<sup>9</sup> Some African countries have started or accelerated the implementation of these interventions in 2000 and 2001, and many have followed in 2002.

To document coverage rates at the outset of the RBM effort, we analyzed nationally representative surveys that measured the coverage in malaria-endemic countries in sub-

Saharan Africa with two of these principal strategies: antimalarial treatment in febrile children less than five years old and use of mosquito nets in children less than five years old.

### METHODS

We analyzed data from household surveys conducted in malarious African countries between 1998 and early 2002. These included 13 Demographic and Health Surveys (DHS), predominantly sponsored by the United States Agency for International Development (DHS; ORC Macro, Calverton, MD) (<http://www.measuredhs.com>), and 23 Multiple Indicator Cluster Surveys (MICS) conducted by the United Nations Children's Fund (<http://www.childinfo.org>). The surveys are implemented once every 3–5 years in many developing countries. The DHS collect data on a wide range of topics related to population and health programs; MICS surveys focus mainly on social indicators related to the well being of children, and interviews are of shorter duration. Both surveys select nationally representative samples, using a two-stage design in most countries. In the first stage, sampling clusters (usually census enumeration areas) are selected proportional to size. In the second stage, a sample of households is selected from a complete household listing in the cluster. Trained survey teams administer standardized questionnaires translated into local languages. The DHS and MICS surveys used similar questionnaires. For all outcomes, data obtained from the survey samples are weighted by the proportional size of the population living in each of the enumeration areas to arrive at national averages.

For children reported to have had fever in the two weeks prior to the survey, DHS and MICS surveys record the reported use of drug treatment, including analgesics, antipyretics, and locally available antimalarial drugs. These data do not consider the timeliness of the treatment relative to the onset of the fever, or the true effectiveness of each antimalarial against malaria, but they represent the single type of standardized, community-based information on antimalarial treatment coverage at national level. In this review, we counted as antimalarials chloroquine/Nivaquine, sulfadoxine-

pyrimethamine/Fansidar, primaquine, quinine, amodiaquine/Flavoquine, halofantrine, and artemisinin derivatives.

For reported use of mosquito nets, besides ITNs also untreated nets were considered because the latter have a significant own epidemiologic impact<sup>10,11</sup> and their coverage indicates the potential for future coverage with ITNs. Since the impregnation status of nets was not in all surveys reported, the categories were ITN and any net. We focused on use during the night preceding the survey. In the few DHS where net coverage of children less than five years old was recorded at the household level (as all, some, or none of the children, rather than at the level of the individual child), we defined child coverage as the proportion of households reporting that all children slept under a net. Nets reported to ever have been impregnated with insecticide were considered as ITNs.

Not every survey recorded both net use and fever treat-

ment, but surveys recording coverage of either intervention alone were also considered. For stratification of outcomes by urbanicity, the designations of urban and rural were based on country definitions.

## RESULTS

Data included coverage with fever treatment in 32 countries, and use of any nets or ITNs in 30 and 28 countries, respectively. The median number of sampled children less than five years old per survey was 4,784 (range = 2,185–23,296). Reported fever within the previous two weeks in children less than five years old was high (median = 29%, range = 4–46%, Table 1); only in seven countries was the rate less than 20%.

TABLE 1  
Reported forms of treatment for febrile children under five years of age in 32 malaria-endemic countries, 1998–2002

Country	Source,* year	% of children with fever	Form of treatment											
			Antimalarial (%)					Any antimalarial	Analgesic (%)			Other (%)		
			Chloroquine/ Nivaquine	Sulfadoxine- pyrimethamine/ Fansidar	Quinine	Amodiaquine/ Flavoquine	Other anti- malarials†		Paracetamol	Aspirin	Ibuprofen	Other medicines	Don't know	No treatment
Angola	MICS 2001	25	57	1	5	—	0.6‡	63	77	—	—	20	—	—
Benin	DHS 2001	41	59§	1	—	2	—	60	—	—	—	80	—	9
Burundi	MICS 2000	17	23	2	6	—	—	31	15	—	—	8	5	—
Cameroon	MICS 2000	24	48	1	26¶	—	—	66	51	—	—	45	5	—
Central African Republic	MICS 2000	32	66	0	11#	—	—	69	71	—	—	30	0	—
Chad	MICS 2000	29	31	1	—	—	—	32	56	—	—	8	1	—
Comoros	MICS 2000	31	62	4	—	—	—	63	64	—	—	12	2	—
Congo DR***	MICS 2001	41	45	0.8	—	—	—	45	61	—	—	29	4	—
Côte d'Ivoire	MICS 2000	31	56	3	—	—	—	58	32	—	—	25	2	—
Equatorial Guinea	MICS 2000	25	41	19	—	—	—	49	82	—	—	28	3	—
Eritrea	DHS 2002**	—	—	—	—	—	—	4	—	—	—	—	—	—
Ethiopia	DHS 2000	28	2	1	1	—	—	3	—	8	0.6	5	2	78
Gabon	DHS 2000	29	39	—	18††	—	41	—	—	—	—	31	1	7
Gambia	MICS 2000	15	55	3	—	—	—	55	61	—	—	13	4	—
Ghana	DHS 1998	27	—	—	—	—	—	61	—	—	—	—	—	—
Guinea-Bissau	MICS 2000	42	58	3	—	—	—	58	67	—	—	19	2	—
Kenya	DHS 1998	42	x	x	—	x	x	40‡‡	—	—	—	—	—	—
Kenya	MICS 2000	15	44	26	—	—	—	65	69	—	—	27	1	—
Madagascar	MICS 2000	16	30	1	34	—	—	61	53	—	—	44	4	—
Malawi	DHS 2000	42	1	23	—	—	3	27	—	—	—	3	1	—
Mali	DHS 2001	27	38	—	—	20	—	—	14	—	—	27	—	—
Mauritania	DHS 2000–2001	31	21	—	17§§	—	12	—	—	—	—	10	1	39
Niger	MICS 2000	42	48	0	—	—	—	48	15	30	—	19	2	—
Rwanda	MICS 2000	33	7	2	4	—	—	13	11	—	—	15	40	—
Rwanda	DHS 2000	33	5	1	3	—	—	9	—	—	—	0	—	5.6
Sao Tome and Principe	MICS 2000	29	61	1	—	—	—	61	76	—	—	0	2	—
Senegal	MICS 2000	21	36	1	—	—	—	36	49	—	—	19	4	—
Sierra Leone	MICS 2000	46	60	4	—	—	—	61	66	—	—	43	7	—
Somalia	MICS 2000	17	19	0	—	—	—	19	66	—	—	14	2	—
Sudan, Northern	MICS 2000	21	49	1	—	—	—	50	12	—	—	11	1	—
Swaziland	MICS 2000	4	23	6	—	—	—	26	59	—	—	0	4	—
Tanzania	DHS 1999	35	53	0	—	—	—	53	—	—	—	—	—	—
Togo	MICS 2000	36	59	3	—	—	—	60	65	—	—	39	2	—
Zambia	MICS 1999	14	56	2	2	—	—	58	60	—	—	2	18	—

\* MICS = Multiple Indicator Cluster Survey; DHS = Demographic and Health Survey; \*\*\*DR = Democratic Republic.

† Any other locally available antimalarial drug.

‡ Halofantrine.

§ Chloroquine plus primaquine.

¶ 22% quinine and 4% Quinimax.

# 4% quinine and 7% Quinimax.

\*\* Preliminary data.

†† 16% quinine and 2% Arsiquinoforme.

‡‡ Antimalarial drugs included chloroquine, sulfa combinations, halofantrines, amodiaquine and artemisinin derivatives, but the coverage with each separate drug (marked with x) was not specified in the report.

§§ 4% Quinimax and 13% Arsiquinoforme.

The overall reported coverage of child fevers with any antimalarial treatment (not considering its timeliness or true effectiveness) was more than 50% in 17 of 29 countries. Treatment coverage was highest in the Central African Republic (69%) and Cameroon (66%, Figure 1). The overall median treatment coverage was 53%. Northern Sudan and Somalia, areas in conflict situations, had coverages with antimalarial treatment of 50% and 19%, respectively.

If we consider the use of antipyretics and analgesics in addition to antimalarials (Table 1), the use of any treatment of child fevers was variable, e.g., 22% in Ethiopia and 91% in Benin. Some mothers were not able to report the type of drug(s) used; this occurred most frequently in Rwanda (40%) and Zambia (18%). In 17 countries, the proportion of febrile children who received analgesics (paracetamol, aspirin, or ibuprofen; median = 60%) was higher than the proportion treated with an antimalarial drug. Among antimalarials, chloroquine was by far the most commonly used drug, constituting a median of 84% of all antimalarial treatments reported.

The use of any net for children less than five years old was less than 40% in all but The Gambia, Guinea-Bissau and Sao Tome and Principe; overall median use was 15%. (Figure 2). The proportion of children less than five years old sleeping under an ITN was generally low. In 23 countries, ITN use for children less than five years old was at or less than 5%, at an overall median use of 2% (Figure 2). Only two of the smallest countries, Sao Tome and Principe and The Gambia, recorded coverages of more than 10%.

**Within-country distribution in coverage.** Examination of within-country distributions showed geographic variation in coverage. The rate of antimalarial treatment was higher in

urban areas in 24 of 28 countries, including Senegal, Guinea-Bissau, and Côte d'Ivoire, but it was higher in rural areas in Somalia. Pooled over all countries, antimalarial treatment coverage was 1.2-fold higher in urban areas (Figure 3). Also, net coverage tended to be higher in urban areas than in rural ones. For any net, this was the case in 25 of 29 countries; for ITNs in 25 of the 28 countries. The urban-rural difference was larger for ITNs than for any net (Figure 3): pooled over all countries, the coverage ratio urban-to-rural was 2.1 for any net and 3.9 for ITNs. In contrast to the coverage with these interventions, reported incidence of child fevers was slightly more common in rural than in urban areas in most (24 of 30) countries. Pooled over all countries, fever was 1.1-fold more common rurally.

## DISCUSSION

With data from 34 African countries collected between 1998 and 2002, just prior to wide-scale RBM implementation, this review on population coverage with two key RBM antimalarial interventions provides a benchmark against which future progress can be measured.

The response to child fever with use of antimalarials was substantial in many countries. However, the overall coverage as measured in these surveys is likely to considerably overestimate the frequency of effective treatment, which as yet remains unknown. First, the most common drug reported was chloroquine (Table 1), which in most of the survey populations is no longer effective due to parasite resistance,<sup>12</sup> even when the national treatment policy still recommends it. Sec-

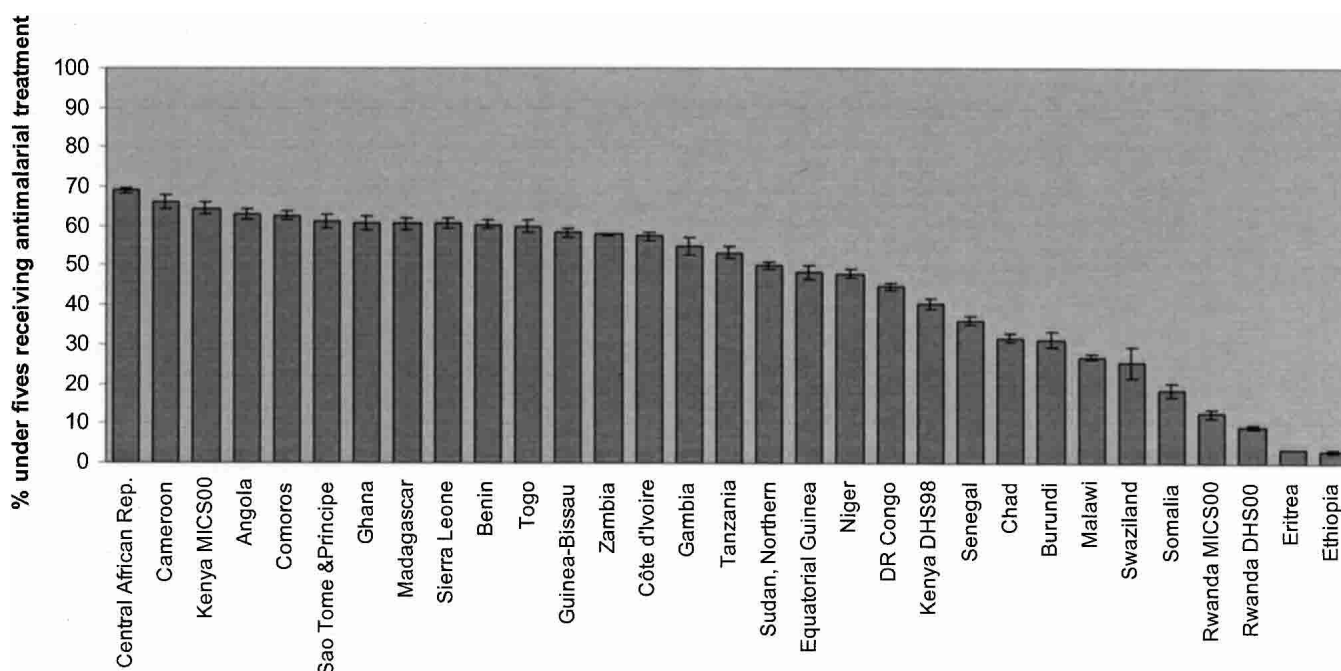


FIGURE 1. Reported use of antimalarial treatment in children less than five years of age with fever in the past two weeks (irrespective of dosage and of timeliness relative to the onset of the fever) in 29 malaria-endemic African countries, 1998–2002. The presented estimates are nationally representative, based on weighted data from cluster-sampled Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) (for precise sources, see columns 1 and 2 in Table 1). The following antimalarials were counted: chloroquine/Nivaquine, sulfadoxine-pyrimethamine (Fansidar), primaquine, quinine/Quinimax/Arsiquinoforme, amodiaquine/Flavoquine, halofantrine, and artemisinin derivatives. Error bars indicate the standard error of the mean based on the size of the sample of febrile children in the survey. Rep. = Republic; DR = Democratic Republic.

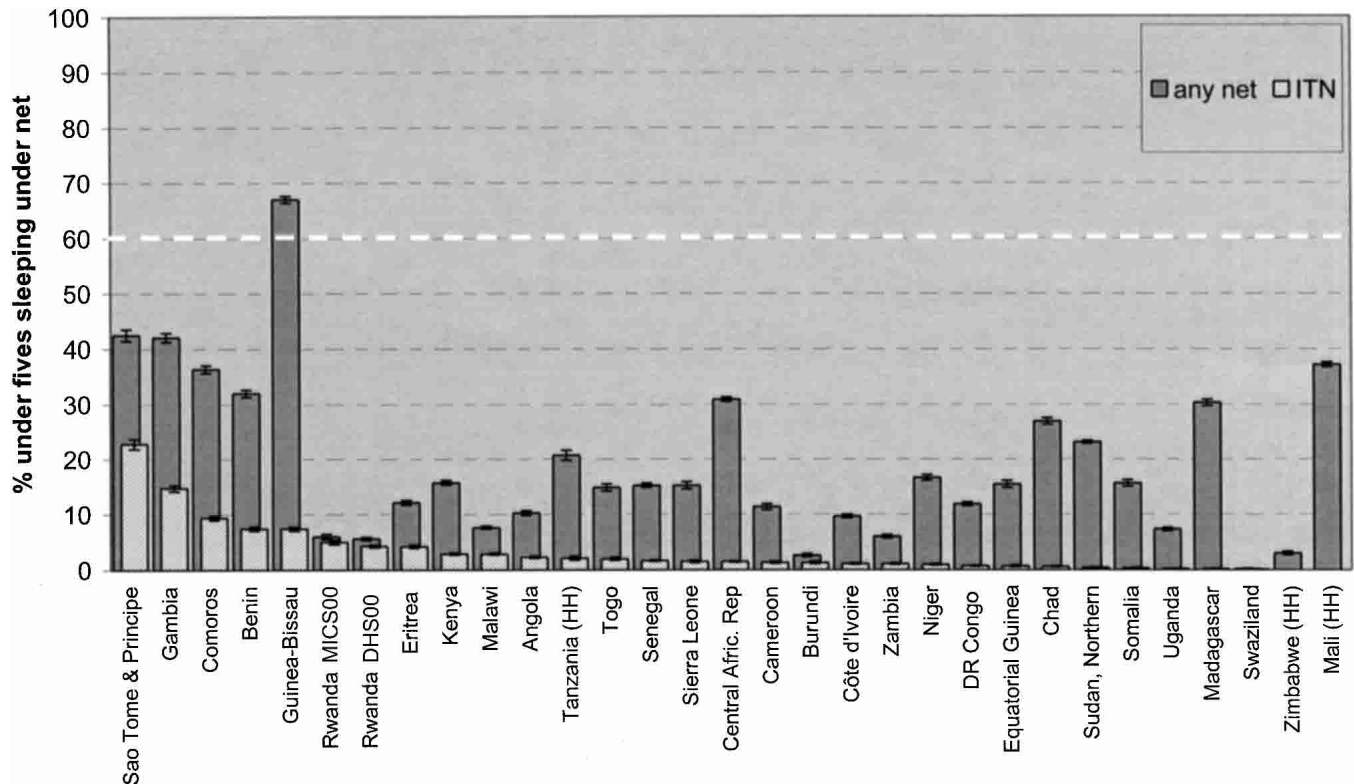


FIGURE 2. Proportion of children less than five years of age who slept under a mosquito net (any) or an insecticide-treated net (ITN) the previous night in 30 malaria-endemic African countries, 1998–2002. The presented estimates are nationally representative, based on weighted data from cluster-sampled Demographic and Health Surveys and Multiple Indicator Cluster Surveys (MICS). The dashed horizontal line represents the 60% target coverage with ITNs defined for Africa in the Abuja Summit on Roll Back Malaria. Error bars indicate the standard error of the mean based on the sample size of the survey. For sources, see columns 1 and 2 in Table 1. Estimates for Kenya are from the MICS survey. In Zimbabwe and Mali, no data were available on ITN coverage. HH = coverage based on proportion of households with all children less than five years of age sleeping under a net, instead of the proportion of children sleeping under a net; Afric. = African; Rep. = Republic; DR = Democratic Republic.

ond, an unknown but probably large proportion of these treatments will not have been prompt and thus too late to be life-saving.<sup>13</sup> Of the surveys analyzed here, only the DHS in Rwanda and Malawi recorded the timeliness of the treatment relative to the onset of fever. Here, approximately 65% of antimalarial treatments were reported to have been given the

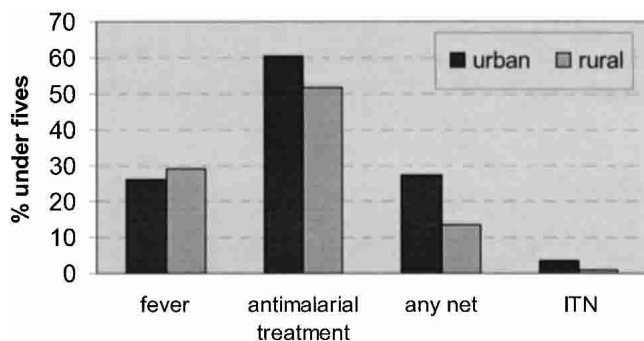


FIGURE 3. Urban-rural differentials in the proportion of children less than five years old with fever in the past two weeks and the coverage of children less than five years old with mosquito nets and of febrile children less than five years old with antimalarial treatment. Shown are the median for 30 countries for fever, 28 countries for fever treatment, 29 countries for mosquito nets, and 28 for insecticide-treated nets (ITNs).

same or next day. Earlier surveys measured widely varying proportions of treatments that occurred within one day of onset of symptoms, ranging from 14% in Guinea to more than 80% in Malawi<sup>14</sup> and Togo.<sup>15</sup> Finally, none of the surveys measured the dosaging of antimalarial treatment, whereas inadequate drug dosaging (mostly underdosing) is common, involving between 42% (Holtz TH and others, unpublished data)<sup>14</sup> and 71%<sup>15</sup> of treatments.

Evaluation of actual coverage with effective treatment may be improved with the application of effectiveness criteria to the data, whereby for example chloroquine would be counted as not effective or only partially effective in most east African countries (this was beyond the scope of this study). Data on promptness and dosaging of treatments are forthcoming from ongoing DHS, which include these questions systematically under the recently implemented malaria module. Practically, the gap between the overall use of antimalarials and coverage with prompt effective treatment implies a need for not only drug availability, but also accompanying education of caretakers on correct home-based management including fever recognition and promptness of response.

Coverage with ITNs was very low across the African continent. However, the finding of considerable use of any mosquito net (treated and untreated nets) in several countries (Figure 2) confirms that cultures of net use exist that will facilitate the expansion of ITN coverage. Actual protection

by nets may be somewhat lower than reported use since not all nets are used correctly. For example, in small-scale surveys in Malawi and Kenya, between 80% and 90% of nets had holes,<sup>16–18</sup> and in a survey in Burundi, up to one-third of the nets were hung incorrectly.<sup>19</sup> Correctness of usage is especially critical for untreated nets, which provide exclusively the protection from physical separation from mosquitoes and not the protection from repellence and killing of the insects. However, the state of the net may also influence efficacy for ITNs that have not recently been re-treated. Studies conducted so far in the context of ITN trials or social marketing projects indicate that nets are often not reimpregnated or are reimpregnated infrequently.<sup>17,18,20</sup> The frequency of the insecticide reimpregnation will become a critical component of the monitoring of ITN coverage, and this is to be measured in future DHS and MICS surveys. Given the recency of ITN availability and promotion, however, the ITNs in the surveys conducted between 1998 and 2002 must all have been relatively new so that their overall coverage, irrespective of reimpregnation status, should not grossly overappreciate protective coverage.

Comparison of health indicators among surveys (including others than those presented here) suggests that the DHS and MICS surveys give a fairly typical and consistent picture of intervention coverage in countries, although the outcomes must not be taken exact to the percentage point due to design and sampling issues. For Benin, data on child coverage with any net from DHS 2001 and the Knowledge, Attitudes, and Practice Survey in 1999 are in good agreement, at 32% and 39%, respectively. In Senegal in 2000, coverages with any net were 15% under the MICS survey and 18% in baseline surveys of the Netmark program,<sup>21</sup> with 2% and 5% for ITN, respectively. Zambia, however, recorded coverage with any net of 6.4% under the MICS survey in 1999, and 12% under Netmark in 2000; for ITNs corresponding coverages were 0.1% and 4.1%. The latter differences are beyond the small margin of error of the large-scale surveys (error bars in Figures 1 and 2), and may rather have resulted from a difference in the provinces sampled: all nine provinces under the MICS survey versus five districts in five different provinces under Netmark, or from increasing net usage between 1999 and 2000. For The Gambia, use of any net was 42% in the MICS 2000 survey and 71% in a nationwide survey in rural areas in 1991;<sup>22</sup> no obvious explanation is available for this apparent decrease.

For antimalarial treatment, in Kenya, use of any antimalarial for febrile children was 65% in the MICS survey in 2000, 40% in the 1998 DHS, and 30% in the 1993 DHS. This possibly represents an improvement over time in treatment seeking, although not necessarily in the coverage with effective treatment, since for the latter, increasing resistance to chloroquine should also be considered. In Rwanda in 2000, MICS and DHS surveys measured coverages of 13% and 9.2%, respectively, with similar distributions over chloroquine and sulfadoxine-pyrimethamine. In Malawi, the 2000 DHS measured coverages with any antimalarial of 27% at any time and of 19% within two days. The 1992 DHS in Malawi recorded a similar coverage with any antimalarial at any time of 29%, but in another nationwide survey in 1992, the corresponding rate was 59% with 47% being prompt.<sup>14</sup>

Given that ITN were virtually non-existing until the early 1990s, the present data suggest that non-negligible progress

has been made in ITN coverage. In some countries, including Tanzania and Kenya (where in 1990 and 1996 rates were only 5% and 6% in two districts<sup>17,23</sup>), usage of untreated nets increased as well, whereas overall net usage remained fairly stable since the 1980s in west African countries such as The Gambia<sup>22,24,25</sup> and Guinea-Bissau.<sup>25</sup> However, the pace of increase in the use of ITNs so far is grossly insufficient to achieve the 60% coverage target by 2005. More impressive results within a few years have been documented in specific ITN promotion programs, among others in Burundi,<sup>26</sup> Tanzania,<sup>27</sup> and Ghana,<sup>28</sup> indicating that with increased financial and human resources it should be possible to reach set goals.

From the perspective of establishing current coverage with mosquito nets and antimalarial treatment at the country level, the presented data have several limitations. First, the surveys were designed to examine a variety of health and population issues and they were not optimal in the medical identification of malaria episodes. Reported fevers are an imprecise indicator for child malaria due to seasonal variations and overlap with other childhood diseases,<sup>29–31</sup> which may result in erroneous estimates of the fraction of true malaria episodes that were treated with antimalarials. On the other hand, the absence of good alternative clinical malaria definitions is the rationale behind the World Health Organization/Integrated Management of Childhood Illness recommendation that in malaria-endemic areas all children less than five years old with acute fever (in the absence of specific other symptoms such as measles spots) be presumptively treated with antimalarials.<sup>32</sup> Therefore, the indicator fever treatment corresponds to the health practice we aim to monitor.

Second, not every survey was truly nationally representative. Some districts were excluded due to problems related to conflict and resulting insecurity. For example, the Uganda DHS did not cover the northern districts and the MICS survey in Angola excluded a number of inaccessible areas, which were replaced by clusters elsewhere.

Third, surveys were performed at different times in relation to the malaria transmission season, and many took place (in part) during the dry season. The use of mosquito nets may be two-fold or higher in the rainy months during which most malaria transmission occurs,<sup>24,28,33,34</sup> so that DHS and MICS surveys may underestimate the effective coverage. With regard to fever treatment, the season of the survey will influence the fraction of fevers that is truly malaria and the fraction of malaria episodes that is not reported as fever. Treatment of fevers with analgesics or antipyretics instead or with antimalarials may be more appropriate in some seasons than in others, further hampering the interpretation of data on fever treatment.

Finally, national surveys include non-malarious areas; therefore, intervention coverage for the population groups actually at risk of malaria may differ from the national estimates. In most countries, coverage was slightly higher in urban areas than in rural areas, where, however, the incidence of child fever (Figure 3) and malaria is higher. The geographic inequity was especially prominent for ITNs, the most novel of the interventions. The resulting upward bias in coverage of populations at actual risk may not be relevant for assessing progress in control over time within one country, but it is critical for comparing coverages across countries. For the latter purpose, it may be preferable to express coverage separately for the population at risk of malaria, or to weigh cov-

erage by the regions' relative malaria risks. Improving geographic reference data in future surveys will, through linkage to malaria risk maps such as Mapping Malaria Risk in Africa (MARA) (<http://www.mara.org.za/>), allow such refinement in national coverage estimates.

To what extent do DHS and MICS surveys fulfill the need for monitoring of progress over time, of malaria control in a broader sense? At the precision shown in Figures 1 and 2, the surveys are capable to demonstrate any meaningful increase in net or treatment coverage in the total survey populations. For example, an increase in ITN coverage from 5% to 10% in a sample of 4,000 children less than five years old would be significant ( $P < 0.0001$ , by chi-square test). At the level of a district with e.g., 200 sampled children, however, the same doubling in coverage would no longer be statistically significant ( $P = 0.058$ ). Furthermore, for short-term progress evaluation and feedback to local malaria control programs, more frequent monitoring than at the 3–5-year intervals between MICS or DHS surveys is desired.

Forthcoming data on IPT in pregnancy from surveys that have implemented a malaria module will allow progress monitoring against the third Abuja coverage target. However, household/individual-based surveys are not the means to assess coverage with community interventions such as residual spraying. Vector control is nevertheless an important component of malaria containment and, in southern African countries such as Madagascar and South Africa, possibly more important than net use and treatment.

In conclusion, the low coverage of these principal interventions at the outset of RBM initiative provides further justification for the RBM partnership effort. The Abuja targets of 60% coverage with ITNs and prompt effective treatment by 2005 remain extremely ambitious. To improve the monitoring of the coverage with antimalarial treatment, surveys need to consider also the promptness and effectiveness of the treatment. Much remains to be done, all requiring focused attention, bold action, and sufficient resources, but the benefits will be visible in saved lives and healthier children.

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